

ICHTHYOFAUNAL DIVERSITY OF BHAGIRATHI RIVER AFTER CONSTRUCTION OF KOTESHWAR DAM IN UTTARAKHAND

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ABSTRACT : An attempt has been made to assess the ichthyofaunal diversity of Bhagirathi river of Uttarakhand state after construction of Koteshwar dam with main focus on important indigenous fish species. Due to the construction of dam, the riverine ecosystem has become fragile resulting into fragmented population of the native species such as *Schizothorax richardsoni*, *Schizothorax progastus*, *B. dero*, *L. dyocheilus*, *Barilius bendelisis*, *Tor putitora*, *Tor tor* etc. The fish catch composition study revealed that the overall maximum contribution (47.2%) to the total fish catch was made by common carp followed by mahseer (40.4%), snow trout (8.4%), minor carp (2.0%) and others (2.0%). Mahseer has established as self sustaining population with different age groups having the weight in the range of 80g to 4.6 kg. Fry and fingerlings are present in the rapids, riffles and pool like structure in shallow areas of the impounded dam. *Schizothorax progastus* was not observed, which shared maximum contribution earlier to dam construction. The density of periphyton-phytoplankton recorded as 182.4-223.4 units l⁻¹. However, the zooplankton was 20.4-34.2 units l⁻¹ with maximum density during winter. Benthic-macro invertebrates were recorded as 132-174.8 units m⁻² with high density in winter and low during monsoon season.

Key words : Bhagirathi river, ichthyofaunal diversity, Koteshwar dam, native species.

INTRODUCTION

Koteshwar dam has created a big reservoir on Bhagirathi river in Tehri Garhwal district of Uttarakhand. It is a run-off-the- river type dam, which is 97.5 m tall and 300.5 m long. The catchment area of the dam is 7691 km² with annual runoff of 8.14 km³. The reservoir area of the dam is 2.9 km² at full supply level and 2.1 km² at minimum draw down level. The water storage capacity of the dam is 88.9 MCM at full supply level and 53.9 MCM at minimum draw down level. Water temperature ranges between 4.3°C (in winter)-16.3°C (in summer). Atmospheric temperature ranges from 26°C during monsoon and 15.5°C during winter. The ecosystem of Bhagirathi has been badly impacted due to river valley modification. The fishery of the river has also been affected. Therefore, conservation and judicious management of coldwater fish resources is very important. The purpose here is to examine existing measures, guidelines and criteria available to manage the fishery of the reservoir for the benefit of public and environment.

Biodiversity is essential for stabilization of ecosystems, protection of overall environmental quality,

for understanding intrinsic worth of all species on the earth (Ehrlich and Wilson, 1991). Himalayan ecosystem is unique in its biodiversity and it is the origin point of two mightiest river systems in Uttarakhand *i.e.* Ganga river system from Gangotri glacier and Yamuna river from Yamunotri glacier having so many rivers like Alaknanda, Bhagirathi, W-Ramganga, Kosi, Yamuna, Saryu, Mandakini and Sharda along with many small streams and tributaries. Fish is an indicator of habitat suitability and health of any aquatic system (Gorman and Karr, 1978), however, thermal regime is an important limiting factor affecting distribution pattern and abundance of fish. Various abiotic and biotic factors are the key factors for determining the fish diversity, community structure and species assemblages in the stream and rivers (Minns, 1980). Suitable spawning ground, shelters and feeding ground play important role in the life cycle of fish and consequently in the sustainability of fish population. Scanty information is available on the aquatic faunal diversity and density for the study area as majority of the earlier studies were focused on the main river course and its major tributaries. In the Himalayan streams, the

distribution of fish depends upon the flow rate, type of substratum, water temperature, availability of food and the hydrographical features of the basin (Sehgal, 1988). Sunder *et al* (1999) enlisted total of 218 fish species for the entire Himalayan region. Himalayan fish fauna was classified under subsistence and commercially important fish groups *i.e.* carps (*Labeo* and *Tor* spp.), lesser barils (*Barilius* spp.), schizothoracines (*Schizothorax* & *Schizothoraichthys* spp.), garrids (*Garra* spp.) and sisorids (*Glyptothorax* and *Glyptosternum* spp.) (Vass, 2005). Coldwater species inhabiting in the Himalayan rivers belong principally to five different families, Salmonidae, Cyprinidae, Cobitidae, Sisoridae and Mastacembelidae; out of which fishes comprising major commercial fishery belong to Cyprinidae represented by three sub-families, i) Cyprininae- Mahseers and minor carps, ii) Rasborinae-Indian trouts, and iii) Schizothoracinae-Snow trouts (Moza, 2002). Though the ecological information and ichthyofaunal diversity of the main rivers are available, but fish diversity affected by dam construction is still lacking in the sustainable fishery of the state. Hence, an attempt has been done to assess the Ichthyofaunal diversity of Bhagirathi river after construction of Koteshwar dam.

STUDY AREA AND METHODS

The study was conducted in Bhagirathi drainage near to Koteshwar dam in Pauri Garhwal district of Uttarakhand. Sampling for fish fauna was carried out using cast net and drag net in the 6 sample sites (upstream and downstream) to represent wide range of habitat conditions with the study area. The density of species wise fish fauna were recorded wherever fish occurred. The biomass of the fish species was calculated based on the total fish catch. A minimum of 15 netting was made for the period of 2 hours in the sampling area to collect the available fish specimen. The percentage catch composition was calculated based on the total weight.

$$\% \text{ Biomass} = \frac{\text{Total weight of the fish species (gm)}}{\text{Total fish catch (gm)}} \times 100$$

Catch per unit effort (CPUE) is the number or weight of fish taken during defined period of effort. The CPUE was calculated as:

$$\text{CPUE} = \frac{\text{Total weight of the fish (kg)}}{\text{Time (hr)}}$$

Fish including their spawns, fry and fingerlings caught from the tributaries were identified up to genera/species level with the help of keys given in Jayaram (1999), Menon (1987), Talwar and Jhingran (1997).

Samples of periphyton were collected by scraping of 3cm² area of the boulders and preserved in 1ml of Lugol's solution. The keys of Ward and Whipple (1959) and Trivedy and Goel (1984) were used for identifying the algae. Horizontal and vertical hauling was carried out by 0.25mm pore size plankton net to assess the species richness of phytoplankton and zooplanktons. Quantitative and density estimation of plankton were made using plankton net and preserved in Lugol's solution for identification using keys given by Pennak (1989); Fitter and Manuel (1986) and Edmondson (1992). Enumeration of plankton samples were done following methods given in APHA (1998). Density of phytoplankton was assessed by counting in Sedgwick Rafter cell.

RESULTS AND DISCUSSION

The mighty river Ganga originates as river Bhagirathi from Gangotri glaciers at Gomukh cave an altitude of about 4100 m ASL in Himalayan region of Garhwal. After of a flow run of about 200km river Bhagirathi meets river Alaknanda at Devprayag and then flows ahead as the holy river Ganga. The river is en-routed with a large number of tributary, which provides an exceptional ground for Ichthyofaunal biodiversity.

Ichthyofaunal diversity and distributional pattern

The earlier studies on fish diversity in Bhagirathi river reveal that a total of 21 species belonging to 12 families of fish species were present, out of these *Tor tor*, *Tor putitora*, *Raimas bola* were found as endangered fishes while *Barilius vagra* and *Garra gotyla gotyla* were found as vulnerable fish species, while *Garra lamta*, *Labeo boga*, *Labeo dero*, *Labeo dyocheilus*, *Puntius chola*, *Puntius sarana*, *Puntius sophore*, *Puntius phutunio*, *Rasbora daniconius*, *Esomus danricus*, *Crossocheilus latius latius*, *Leploephalus guntea*, *Noemacheilus botia*, *Noemacheilus savona*, *Noemacheilus bevani*, *Mystus vittatus*, *Xenentodon cancila*, *Mastacembelus armatus*, *Channa gachua*, *Glyptothorax pectinopterus* were found at low risk (Sharma, 2014).

After the impoundment of dam, the riverine ecosystem has been fragmented into many zones, and the fish population of Bhagirathi river has decreased. A total of 16 fish species were found in the upstream of the Tehri and Koteshwar dam Reservoir. This may be due to the presence of natural habitats to indigenous fish species. A total 10 fish species were found in impacted zone of the dam. Reduced diversity of fish in the impacted zone may be due to the fact that the longitudinal migration of high altitude coldwater fishes is obstructed by the dam.

Before the impoundment, the maximum contribution

Table 1 : The recorded physico-chemical variables at the dam site.

Variables	Autumn (Sept-Oct)	Winter (Nov-Feb)	Summer (March- June)	Monsoon (July- August)
Air temperature (°C)	22.2	16.1	23.4	27.5
Water temperature (°C)	15.3	12.4	17.4	17.1
TDS(mg l ⁻¹)	38.4	24.8	38.8	88.8
Dissolved Oxygen(mg l ⁻¹)	9.8	10.2	9.6	8.8
Free CO ₂ (mg l ⁻¹)	2.8	2.2	2.7	3.6
pH	7.6	7.4	7.6	7.8
Hardness (mg l ⁻¹)	70.2	75.2	61.2	48.6
Alkalinity(mg l ⁻¹)	54.3	56.2	58.4	47.8
Nitrate(mg l ⁻¹)	0.42	0.28	0.48	0.46
Phosphate(mg l ⁻¹)	0.23	0.19	0.52	0.82

(57.9%) to the total fish catch was made by snow trout (*Schizothorax* spp.) followed by *Garra* spp (10.3%), *Tor* spp (9.1%) and *Schizothorax progastus* (6.3%) in the natural environment of Bhagirathi (Sharma, 1988). However, due to the negative effects of Dam construction, the fish composition has been altered drastically. The contribution of *Schizothorax* to the total fish catch reduced to 19.6% and that of mahseer (*Tor* spp) reduced to 4.0% with the negligible contribution of (0.6%) by *Labeo dero* and complete disappearance of high altitude migratory fish species (*Crossocheilus latius*, *Glyptothorax pectinopterus*, *G. madraspatnam*, *G. cavia* and *Pseudechenies sulcatus*) at the impacted site.

The mahseer contributes about 9.14% in Bhagirathi River (Sharma, 1988). Apparently, it does not form a big share of the total fish catch of upper Ganges. But, the mahseer is one of the most important and mighty sport fish of the country. Britishers used to be the royal guest of the then ruler of Tehri State for angling pleasure of mahseer in the Bhagirathi during pre- independent period. Locally, it is known as 'dansula' and 'mahseer'. Mahseer weighing upto 23 kg has been recorded in the River Bhagirathi (Sharma, 1988). The adults ranged from 22.0 to 75.5 cm and juveniles from 9.8 to 21.2 cm in total length in Bhagirathi River (Sharma, 1988). The adults of mahseer (*Tor tor* and *Tor putitora*) are euryphagic omnivorous column feeder and the juveniles are filter feeders. The basic food of adult *Tor tor* is comprised by insects and their larvae, crustacea, algae, diatoms and protozoa.

Mahseer population declined in the entire stretch of the Bhagirathi River due to the changes in the hydrological regime as a result of the construction of Tehri Dam (Chauhan, 2007). The natural flow of river has changed with almost constant water level downstream throughout the year. The earlier existing feeding and spawning grounds were lost due to the sharp reduction in the water level and flooded area downstream the Tehri Dam. The

maximum mean biomass (0.252 g m⁻²) of mahseer was estimated in the month of May and minimum (0.030 g m⁻²) in the month of December before the dam. However, the maximum mean biomass (0.224 g m⁻²) of mahseer was observed in May and minimum (0.025 g m⁻²) in the month of December after the dam. The annual production of mahseer was observed to be 0.129 g m⁻² yr⁻¹ before dam and it reduced to 0.053 g m⁻² yr⁻¹ after construction of the dam. However, the density of mahseer was more at the impacted site than the reference site (Chauhan, 2007).

The density of periphyton-phytoplankton recorded as 182.4-223.4 units l⁻¹. However, the zooplankton was 20.4-34.2 units l⁻¹ with maximum density during winter. Benthic-macro invertebrates were recorded as 132-174.8 units m⁻² with high density in winter and low during monsoon season. The recorded physico-chemical variables at the dam site are summarized in Table 1.

Catch composition

Catch composition is proportional to the average density of the location fished. Catch composition was worked out on the basis of sampling fishing at different sites. The fish catch composition studied revealed that overall the maximum contribution (47.2%) to the total fish catch was made by common carp followed by mahseer (40.4%), snow trout (8.4%), minor carp (2.0%) and others (2.0%). Mahseer has established as self sustaining population with different age groups having the weight in the range of 80g to 4.6 kg. Fry and fingerlings are present in the rapids, riffles and pool like structure in shallow areas of the impounded dam. *Schizothorax progastus* was not observed, which shared maximum contribution earlier to dam construction.

Fish migration

Bhagirathi basin inhabits two major types of migratory species viz. Snow trout (*Schizothorax* spp.) and Mahseer (*Tor* spp.). During the extensive survey, Snow

trout was found as dominant species in the middle zones of these rivers. Snow trout is a short distance migratory species and in the normal course of its life cycle migrates within the stream/tributary to main river from higher elevation to lower elevation during winter months and *vice-versa* during summer. During its upstream movement in the month of April and May this species breeds in the certain pockets especially at the confluence point of the tributaries where there is suitable pool like shelters are available. Similarly during the winter season (late September-early November) the Snow trout migrates towards the lower elevation and during the course of migration breeds in the khads where suitable water temperature and substratum is available. Another migratory species, Mahseer (*Tor putitora* and *Tor tor*) has also been observed through the observation based on the occurrence of juvenile and adult stock during the migratory period.

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